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IMPROVED PAPERMAKING SCREEN PLATE AND METHOD OF CONSTRUCTION

FIELD OF THE INVENTION

The invention relates to the manufacture of paper, paperboard and related products and particularly to the removal of contaminants and oversize particles from pulp flow generally consisting of an aqueous suspension of fibrous materials having a suspended solids concentration between 0.5% and 5%.

BACKGROUND OF THE INVENTION

A common practice in pulp and paper mills is the use of screening devices to separate acceptable and unacceptable particles that differ in relative size, shape and flexibility.

In practice, screening devices vary considerably in configuration, operate with or without being pressurized, and nearly always resemble a perforated plate in which the perforations are in the shape of slots or holes. A wide variety of techniques has been used to produce screenplates including punching, drilling or laser perforating in the case of holes, and machining with milling cutters, abrasive water jets, or lasers in the case of slots. In addition, several manufacturing techniques have been used to produce so called "wedgewire" type screens.

A commonly used screening device is referred to as a pressure screen consisting of a screenplate in the form of a cylinder. For example, the cylinder may have a 30" diameter, 36" length, and a cylinder wall consisting of a perforated screenplate with 0.050" diameter drilled holes closely spaced so as to provide the maximum area available to the flow of acceptable material through the screen.

The process flow consisting of an aqueous suspension of from between 0.5% to 5% fibrous materials is usually introduced to the cylinder interior through an inlet pipe. The accept material passes through the cylinder wall screen perforations or slots and flows out through a pipe located midway between the ends of the cylinder. Contaminants and oversize particles which do not pass through the perforations or slots remain inside the cylinder, and eventually flow into a large opening or pipe located at the end of the cylinder opposite to the inlet end.

In this way, the entering process stream is split into two streams, an accept flow free of contaminants or oversize particles, and a reject flow which has a relatively high concentration of contaminant or oversize particles.

In normal practice, screening cylinders are fitted with a motor driven rotor having as a primary function in nearly all configurations and rotor operating speeds, the intermittent clearing of screen plate openings of accumulated solids so as to permit passage of accept material through the openings. An additional function of the rotor may be to fluidize the suspension, which in general increases in concentration during the separation process.

In the case of pulp and paper applications where pressure screens are used to remove small contaminants from a slurry of papermaking fibers, fine slots are generally preferred over small holes. This is so because a papermaking fiber can more readily pass through a 0.003" wide slot compared with a 0.003" diameter hole, but a 0.005" contaminant particle is rejected in either case.

Early manufacturing of slotted screenplate consisted of using thin circular milling cutters, appropriately spaced on a horizontal milling machine, to produce up to several hundred parallel slots in a flat piece of metal plate. The milling cutters would be lifted at cutting intervals of a few inches and moved back into place after leaving a short un-slotted section to provide the necessary interconnecting points between the remaining metal on either side of the slot.

It is important that the slotted screen plate retain considerable structural integrity. Once it is formed into a cylinder and put into use in a pressure screen, large hydraulic and mechanical forces may act upon it. In order to produce increasingly finer slots in suitably thick plate, a common practice was to mill wide slots only part way through the plate and then use very fine milling cutters centered in the wider slots to cut through the plate surface as illustrated in prior art Figure 1 of the drawing.

In recent years, it has become increasingly common to produce so-called "profile" or "contour" screenplates which generally employ grooves or raised elements, usually oriented parallel to the cylinder axis, i.e., perpendicular to the plane of rotation of the rotor element. A profile or contour screenplate aids considerably in the "fluidization" of the suspension at the screenplate surface, and

results in very significant increases in the capacity of the screening device and in the ability to operate with higher solids concentration in the inlet and accept flows.

More recently, screening devices of the kind shown in Figure 2 of the drawing and which are used in pulping and papermaking applications comprise wedge wire construction to produce the equivalent of a slotted screenplate. This technique involves the use of rolled or drawn wire with non-rectangular cross section. The wedge wires are connected to each other and supported by the back element which in the case of a cylindrical screen is usually a hoop of some type. The distance between supporting hoops is determined largely by the size and the shape of the cross section of the wedge wires. The wedge wires have the general shape and may be generally arranged as shown in Figure 2. As shown, a possible wire width is 0.050" and slot width is 0.004"

It is generally recognized that for many, if not most, pressure screen applications in pulp and paper mills that fine slotted screens are very desirable in order to improve the quality of the pulp or paper produced.

The greatest disadvantage of slotted screens until now is that regardless of the method of manufacture, the available open area is very small and is inevitably reduced when slot width is reduced. Currently, screen cylinders are available with nominal slot widths of 0.004" or less. However, it is not practical, even with wedge wire designs, to have more than about 20 slots per inch. Thus, even without wire-to-wire connecting points on the surface, a maximum open area is about (20 X 0.004")/1.000" = 8.0%. In this instance, the maximum width dimension of the wedge wire cross section is about 0.046" and the depth of the section is likely to be between 1/8" and 1/4". A small open area represents a substantial impediment to the rate of accept flow through screenplates.

SUMMARY OF THE INVENTION

The present invention is directed to increasing the open area in pulp and papermaking screen plates with corresponding increase in accept flow without compromising the quality of pulp and paper achieved with fine slotted screens.

In one aspect, the invention is directed to a method of manufacture of fine slotted screens in which alternating strips of very thin metal and even thinner

metallic spacers, precisely shaped and arranged, are metallurgically bonded over their interconnecting surfaces so as to produce a very fine slotted screen plate with relatively high open area. After assembly and bonding, and after trimming away protruding extremities of spacer strips, the finished screen plate has precise slots about 0.004" wide and a screen plate open area of approximately 27%.

Another aspect of the invention is the screen plate characterized by very fine slots and a substantially increased open area with respect to conventional slotted screens.

The fine slotted screens according to the invention represent a four- or- five-fold improvement in open area compared to current methods. This increase in open area permits paper and paperboard mills with fixed capacity screens and screening systems to improve dramatically the efficiency and quality of the process by greatly reducing the slot size of their replacement screen cylinders.

BRIEF DESCRIPTION OF THE DRAWING

Figures 1a and 1b are fragmentary plan and section views respectively of a prior art milled screen plate in which wide slots extend partly through a plate, and very fine slots are cut through the plate in the center of the wide slots.

Figure 2 is an elevation view partially in section of a prior art wedge wire screening device.

Figure 3 is a section view thereof taken along line 3-3 of Figure 2.

Figures 4a and 4b are plan and edge views of a strip component of a fine slotted screen according to the invention.

Figures 5a and 5b are plan and edge views of a spacer component of a fine slotted screen according to the invention.

Figure 6 is a plan view of an assembly of strips and spacers of Figures 4 and 5.

Figure 7 is a section view taken along line 7-7 of Figure 6.

Figure 8 is a plan view of strips and spacers after bonding and trimming.

Figure 9 is a side view of the strips and spacers of Figure 8.

Figure 10 is an enlarged fragmentary horizontal section view of a

screen plate of the invention in the form of a cylinder, with profile bars separating screen plate sections.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figures 1a and 1b illustrate a prior art slotted screen plate in which a wide slot is cut partly through the plate, and a very fine slot is cut through the plate in the center of the wide slot. The slotted screen plate has nominal slot widths of 0.004", with up to 20 slots per inch. Thus, the maximum open area is approximately (20 x 0.004")/1.000" = 8%

Figures 2 and 3 illustrate a prior art screening device utilizing wedge wire construction to produce the equivalent of a slotted screenplate. Wedge wire construction involves the use of rolled or drawn wire having a non-rectangular cross section. The wedge wires are connected to each other and are supported by a back element, typically a hoop in the instance of a cylindrical screen. The distance between supporting hoops is determined largely by the size and shape of the cross section of the wedge wires. In the example of Figures 2 and 3, the screening device has nominal slot widths of 0.004", with up to 20 slots per inch. Thus, the maximum open area is approximately (20 x 0.004")/1.000" = 8%. In this instance, the maximum width dimension of the wedge wire cross section is about 0.046" and the depth of the section is likely to be between 1/8" and 1/4".

Referring to Figures 4-9 of the drawing, the basic components of a screen plate 10 according to the invention comprise a strip 12 and a spacer 14.

In a preferred embodiment, the strips 12 are about 0.010" thick (T) and 0.20" wide (W_{st}) and are assembled with preform spacers 14a about 0.004" thick (t) and 0.40" wide(W_{sp}) The preform spacers comprise parallel runners or sidepieces 14b with integral cross bars 14c to define generally rectangular or square open areas or passages or slots 16.

A multitude of strips and spacer preforms are assembled and metallurgically bonded through out their intercontacting surfaces 18 (shown shaded in two places, e.g., in Fig 6). An assembly of strips and spacers after bonding appears in Figures 6 and 7. It is observed that the open areas 16 extend past the side edges 12a of the strip thereby providing open ended slots 16 between the

assembled strips, with the slots (Fig 9) having a generally uniform width W_{sl} of 0.004" and a length L_{sl} of about 1.875".

After assembly and bonding, the lateral runners 14b of the spacers are trimmed away by machining or grinding, leaving a complete screenplate (Figures 8 and 9) with very fine slots and a comparatively high open area. The screenplate has about 0.20" thickness (i.e., strip width W_{st}) and with precise slots about 0.004" wide W_{sl} and about 1.875" long L_{sr}

The percent open area of the screenplate is readily determined. With a length l of interconnecting area 18 between strip and spacers of about 0.125" for example, the open area of the screenplate is about (1.875" / 2.000) x (0.004" / 0.014) = 26.8%.

This represents a substantial increase in open area compared to 8% open area in the conventional device of Figures 1 and 2.

In modified embodiments of the invention, screen plates comprise strips and spacers defining slots with a width of 0.005" or less, and a slot length of 3" or less thereby forming at least 15% open area in the screen plates.

In order to create a very fine profile, each of the strips may be provided with a bevelled edge 20 (Figs 4a -4b).

To provide a larger profile, a section 10 comprising several microfine strips and spacers is separated by a larger raised bar 22 (Fig 10) which protrudes above the surface to provide an aggressive contour for a screen cylinder while maintaining a very high open area.

An enlarged horizontal section of the cylinder wall is shown in Figure 10 with raised bars 22 positioned between screenplate sections. A rotor (not shown) within the cylinder causes flow of a pulp slurry, and the raised bars interrupt the flow boundary layer so as to promote flow through the cylinder wall.

In preferred embodiments of the invention, the finished screen plate spacers 14c have a thickness t approximately equal to the width W_{sl} of slots in the screenplate, a width w approximately equal to the width W_{st} of strips, a length l less than four times the width w of spacers 14c, and with spacers in an assembled screenplate separated from each other at intervals approximately equal to two to twenty times the length l of spacer, and preferably two to ten times spacer length.

In use, a screen plate according to a preferred embodiment of the invention is in the form of a cylinder, with the cylinder wall strips 12 and spacers 18 (best shown in Figures 9 and 10) vertically oriented with slots passing through the wall from the interior to exterior of the cylinder. The face of the screen plate 10 of Figure 9 corresponds to the interior cylindrical surface S-S of the screen plate as it appears in Figure 10.

Various changes may be made to the structure embodying the principles of the invention. The foregoing embodiments are set forth in an illustrative and not in a limiting sense. The scope of the invention is defined by the claims appended hereto.